Pestic. Sci. 1998, **52**, 218–222

Effect of Neem Cake on Persistence of Diazinon and Endosulfan in Paddy Soil

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(Received 7 March 1996; revised version received 25 July 1996; accepted 12 August 1997)

Abstract: Experiments were carried out to study the influence of two types of neem cake (solvent-extracted, NC-I and expeller-extracted, NC-II) on the persistence in soil of diazinon and endosulfan applied as commercial formulations. It was found that both types of neem cake applied at 10, 20 or 30 g ha^{-1} prolonged the period of degradation as compared with soils without neem cake amendment, and hence increased the persistence of the insecticides. There was little difference in the effect of the two types of neem cake. Treatment of the soil with insecticide 10 days after amendment with neem cake did not lead to any increase in persistence; for a good response, treatment of soil with insecticide and with neem cake must be done at the same time. © 1998 SCI.

Pestic. Sci., **52**, 218–222 (1998)

Key words: neem cake; insecticide; diazinon; endosulfan; persistence; soil

1 INTRODUCTION

The use of agrochemicals (pesticides and fertilizers) has shown a steady increase in Pakistan during the current decade, five-fold in the case of pesticides and 75-fold in the case of fertilizers. Nitrogen fertilizers are the most important input for increasing the production of agricultural crops, including rice. The interaction of these agrochemicals in the agricultural environment is not clearly understood. Massive use of agrochemicals involves the risk of interfering with the quality of the ecosystem, which might be dangerous from the long-term fertility and pollution point of view.

According to various reports, the application of nitrogen fertilizer has little influence on the persistence of insecticides such as carbofuran.[1] Treatment of soils with commercial formulations of diazinon or parathion to which linear alkyl sulfonate or alkyl benzene sulfonate had been added increased the persistence of insecticide residues.[2] Experiments carried out with various types of straw and with potato foliage caused marked biological immobilization of nitrogen, resulting in reduced nitrogen loss, depending on the turnover rate of the materials and their nitrogen contents.[3] Dichlorprop and diazinon mixture used to control fruit fly and weeds resulted in yield increases in barley when fertilized with N + P + K (90 + 90 + 90 kg ha^{-1}) or N + K (120 + 120 kg ha^{-1}), which is an example of the effect of interaction of pesticides and fertilizer on crop yield.[4] Application of nitrogen in split doses, coated and controlled-release fertilizer and/or organo-inorgano sources of nitrogen, and root-zone placement of nitrogen as modified urea are the major recommendations being followed for improving nitrogen–insecticide combinations, involving diazinon and other insecticides, in rice. It was observed that combined application of urea with the insecticide carbofuran had no deleterious effect on urea transformation in the soil.[5] The addition of urea did not affect the insecticidal activity of endosulfan.[6] Neem cake has been reported to reduce nitrogen loss and encourage nitrogen fixation when applied to rice fields in India and IRRI.[7]

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 Pestic. Sci. 0031-613X/98/$17.50. Printed in Great Britain

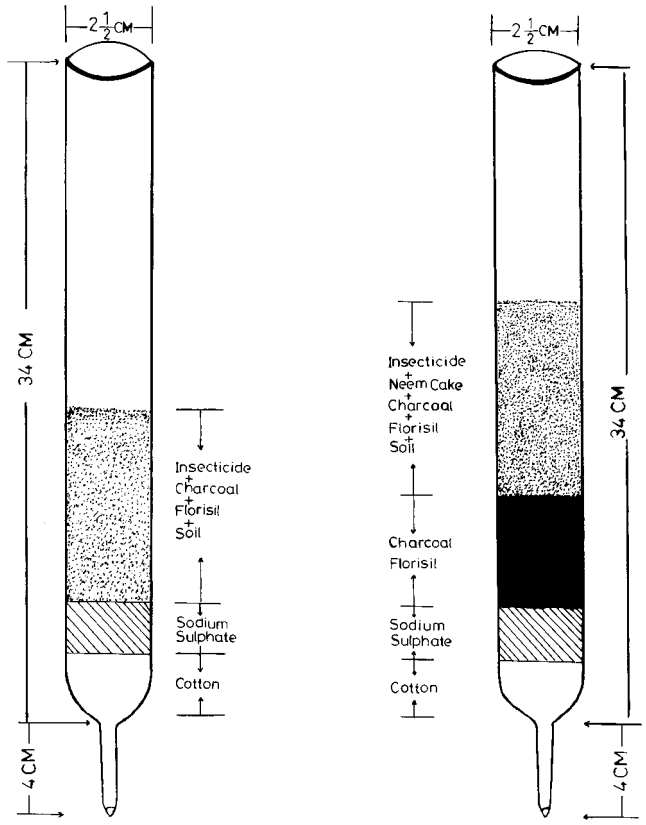

Fig. 1. Column used for the extraction of pesticides from soil with and without neem cake. Pesticides: (a) diazinon 10G; (b) endosulfan 35EC.

To cope with the increased demand for fertilizer and maintain soil fertility, neem cake (the product left after oil extraction) had been selected, as it exhibits systemic insecticidal and apparent fertilizer properties when added to the water in rice fields,[8] and shows inhibition of pesticide degradation.[9] Neem cake contains more nitrogen, phosphorus, calcium and magnesium than does farmyard manure. The abundance of neem trees in Pakistan is an advantage for the use of this product. The present work was initiated to find the influence of neem cake on the persistence of diazinon ('Basudin' 10G) and endosulfan ('Thiodan' 35EC), as these insecticides are commonly applied in rice fields.

2 EXPERIMENTAL METHODS

2.1 Materials

2.1.1 Reagents and solvents

These were: charcoal activated for 4 h at 120°C; Florisil 60–100 mesh, activated; ammonium hydroxide solution, 250 g litre^{-1}; and anhydrous sodium sulfate.

2.1.2 Glassware

A glass column, 34 cm × 2·5 cm diam. fitted with 4 cm × 0·1 cm jet at lower end was employed, plus a microsyringe, 100 μl and normal glass tubes, conical flasks and volumetric flasks.

2.1.3 Instruments

The instruments used were a Pye Unicam series 204 gas-liquid chromatograph (see Section 2.2.4 for column details), a rotary evaporator and an autoclave.

2.1.4 Insecticides

Diazinon 100 g kg^{-1} granules ('Basudin' 10G) and endosulfan 357 g litre^{-1} EC ('Thiodan' 35EC) were the two insecticides used.

2.1.5 Neem cake

The two types of neem cake were NC-I, oil extracted by Soxhlet using hexane as solvent and NC-II, oil extracted by a commercial expeller.

2.1.6 Soil

Paddy field soil was collected from a rice-growing area in Punjab province, and had the following properties: type, loamy clay; total nitrogen, 450 mg kg^{-1}; phosphorus, 7·0 mg kg^{-1}; potassium, 70 mg kg^{-1}; pH, 8·5; organic matter, 0·8%; sand, 35·8%; silt, 38·4%; clay, 25·8%. The soil was analysed for traces of insecticides by standard methods.[10]

2.2 Methods

2.2.1 Experiment I

Four treatments were made, using 25 g soil in each case:

(a) Soil, sterilized (untreated control)
(b) Soil, unsterilized (treated control)
(c) Soil, unsterilized, + 0·25, 0·50 or 0·75 g NC-I (equivalent to 1, 2 and 3 tonne ha^{-1}, respectively)
(d) Soil, unsterilized, + 0·25, 0·50 or 0·75 g NC-II.

Insecticide was added to each treatment at a level equivalent to the recommended field rate: 4·375 mg 'Basudin' 10G (= 1·73 kg AI ha^{-1}) or 0·7 ul 'Thiodan' 35EC (= 1·0 kg AI ha^{-1}).

The soil samples were placed in glass tubes and flooded with sterilized water which was maintained during the incubation period of two months at room temperature. Samples were taken for analysis of 0 h, and after 1, 15, 30 and 60 days. All treatments/times were run in triplicate.

2.2.2 Experiment II

The treatments and general procedure were as in Experiment I (Section 2.2.1). Sterilized and unsterilized soils were blended with the indicated levels of NC-I and NC-II and kept at room temperature for 10 days. The appropriate levels of insecticide were then added and samples were analysed at 0 h and after 1, 15, 30 and 60 days at room temperature.

2.2.3 Analytical procedures

The soil samples were air dried, homogenized and extracted as described in detail elsewhere.[10] The treated soil (25 g) was mixed with charcoal (1·0 g) and Florisil (1·0 g) and placed above a layer of sodium sulfate in a column as described in Section 2.1.2. In the case of samples amended with neem cake, a further layer of charcoal (0.5 g) + Florisil (10 g) was placed between the soil mixture and the sodium sulfate (Fig. 1). The samples were extracted with hexane + acetone (4 + 1 by volume). The solvent was evaporated, the residue taken up in hexane and made up to 5 ml in a volumetric flask for GLC analysis.

The lower limit of detection of the method was found to be 0·1 mg ha^{-1}.

2.2.4 GLC analysis

The samples were analysed by GLC using an electron capture detector for endosulfan and a flame ionization detector for diazinon. The parameters were as follows:

Endosulfan. Column, 1 m × 4 mm, 1·5% SP-2250/1·95% on 100/120 Supelcoport (Supelco Inc.); detector temperature, 250°C; injector temperature, 175°C; column temperature, 180°C; attenuation, 512; chart speed, 120 s cm^{-1}.

Diazinon. Column, 3% OV-101 Chrom W A-W-DMCS 100/120; detector temperature, 250°C; injector temperature, 250°C; column temperature, 180°C; attenuation, 256; chart speed, 120 s cm^{-1}.

3 RESULTS AND CONCLUSIONS

3.1 Diazinon

The persistence of diazinon in soil with and without neem cake is shown in Fig. 2. After 30 days, the treated control (unsterilized soil) showed 50% degradation,

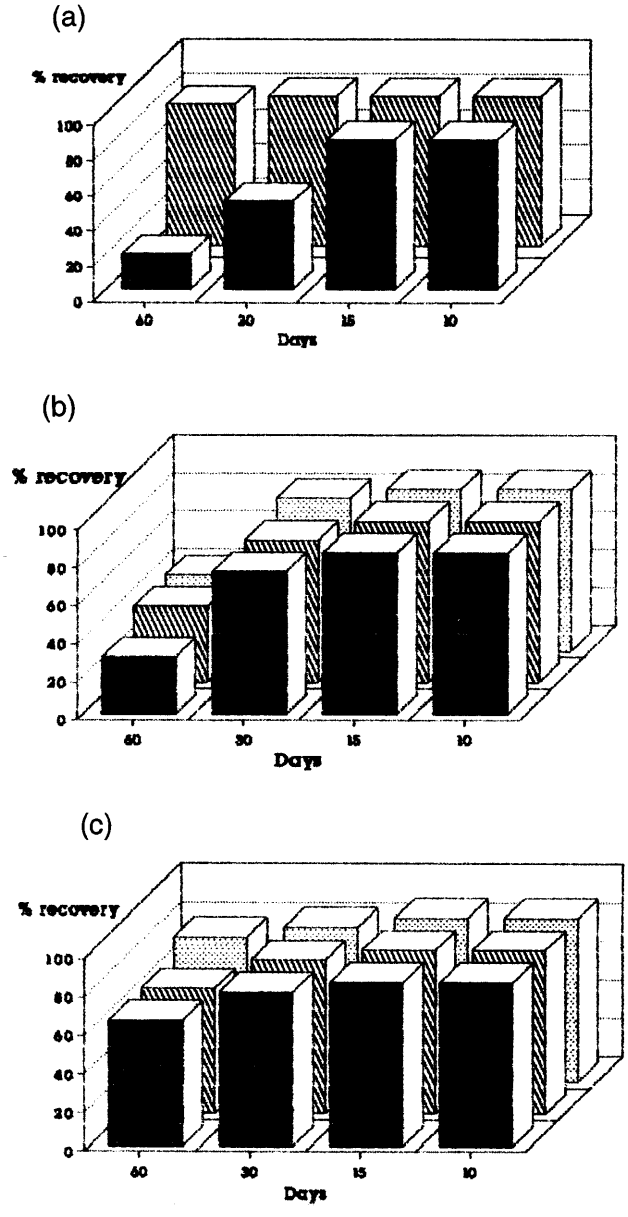

Fig. 2. Persistence of diazinon in (a) unamended soil: (▨) sterilized, (■) unsterilized; (b) soil amended with neem cake NC-I: (■) 10, (▨) 20, (▩) 30 g kg^{-1}; (c) soil amended with neem cake NC-II: (■) 10, (▨) 20, (▩) 30 g kg^{-1}.

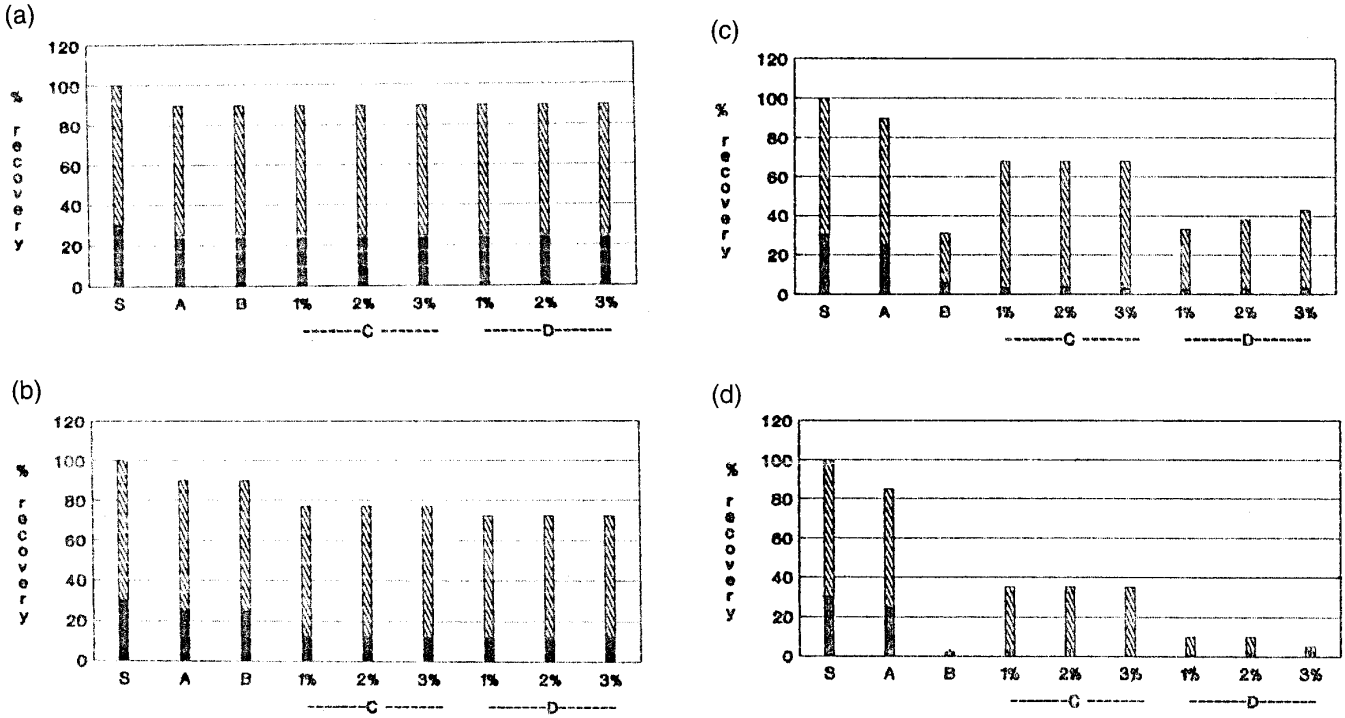

Fig. 3. Persistence of endosulfan in unamended and amended soils (a) 10, (b) 15, (c) 30, (d) 60 days after treatment. (▨) alpha isomer, (■) beta isomer. S: standard; A: sterilized; B: unsterilized; C: amended with neem cake NC-I; D: amended with neem cake NC-II.

while soils amended with neem cake at 1, 2 and 3% caused 20, 20 and 10% degradation, respectively. At this stage, there was little difference between NC-I and NC-II. After 60 days, there was 85% degradation in the treated control, 80, 70 and 65% in the presence of NC-I (hexane-extracted) at 1, 2 and 3%, respectively, and 45, 45 and 35% with NC-II (expeller-extracted).

In Experiment II, where the insecticide was added 10 days after amendment with neem cake, persistence was not prolonged in any treatment. From this, it is con-

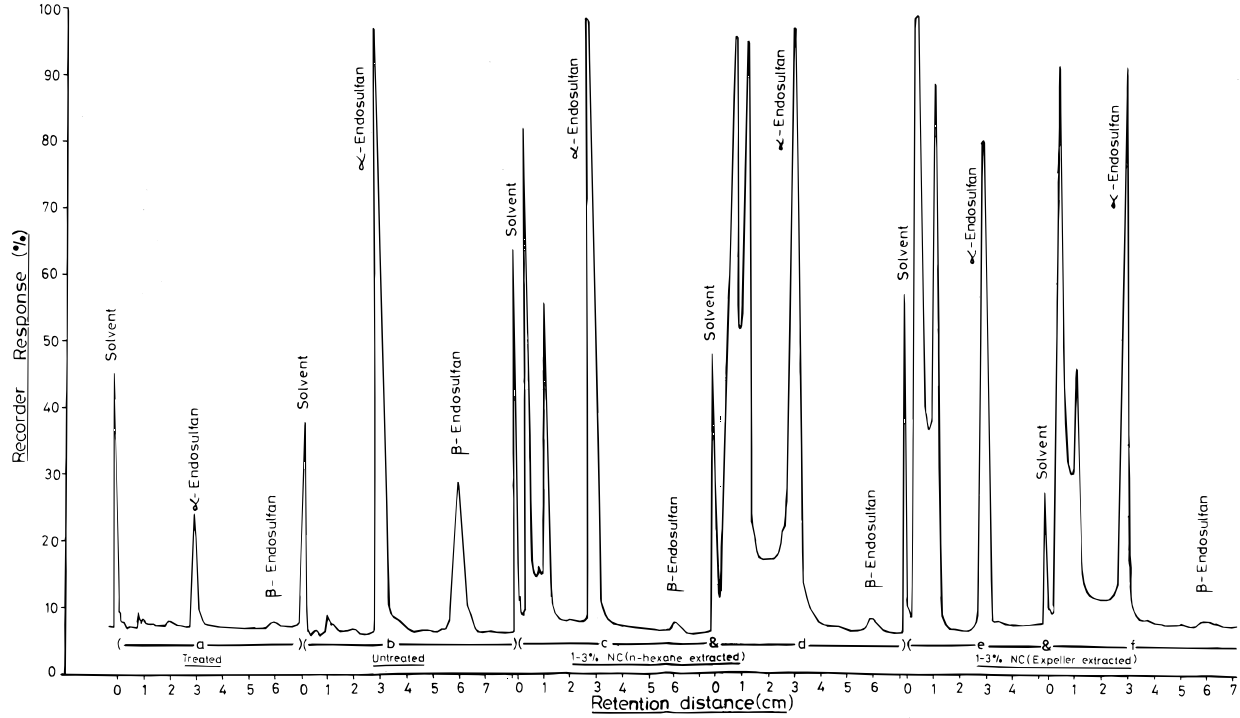

Fig. 4. Gas chromatograms of endosulfan extracted from unamended soil and soils amended with neem cakes NC-I and NC-II one month after treatment.

cluded that neem cake must be applied along with the insecticide to provide any improvement in persistence.

3.2 Endosulfan

The endosulfan formulation used contained the alpha and beta isomers in the proportion 70 : 30. Up to 10 days, there was no marked difference between any of the treatments, but after 15 days, there was some loss of both isomers from the soils amended with neem cake (Fig. 3). The treated control showed little degradation up to 15 days, but after 30 days, 80% degradation of alpha isomer and 70% of beta was observed, as has been reported earlier.[11] The persistence of the alpha isomer was increased in the presence of NC-I, nearly 90% remaining after 30 days and nearly 50% after 60 days. NC-I was slightly more effective than NC-II in improving the persistence of alpha-endosulfan, but neither affected the persistence of the beta isomer.

Gas chromatograms obtained at the end of one month are shown in Fig. 4.

Experiment II gave similar results to those obtained with diazinon (Section 3.1).

4 CONCLUSIONS

Amendment of the soil with either type of neem cake reduced the rate of degradation of diazinon and of alpha-endosulfan. In the field, this could increase the persistence of the insecticides and thus perhaps make it possible to reduce the number of applications required, provided that the neem cake is added at the same time as the insecticides are applied. No insecticide degradation was observed in sterilized soil, suggesting that it is caused by micro-organisms, and the effect of amendment with neem cake may be to disturb the balance of these. This effect may be only temporary, since no improvement in persistence was found when the insecticide was added 10 days after amendment. However, it should be studied in more detail to establish whether there are any potential negative side-effects on the fertility and consequently the production capacity of the soil.

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